



Europäisches
Patentamt

European
Patent Office

Office européen
des brevets

(20.12.2004)

Bescheinigung

Certificate

Attestation

Die angehefteten Unterla-
gen stimmen mit der
ursprünglich eingereichten
Fassung der auf dem näch-
sten Blatt bezeichneten
europäischen Patentanmel-
dung überein.

The attached documents
are exact copies of the
European patent application
described on the following
page, as originally filed.

Les documents fixés à
cette attestation sont
conformes à la version
initialement déposée de
la demande de brevet
européen spécifiée à la
page suivante.

Patentanmeldung Nr. Patent application No. Demande de brevet n°

03104802.8

Der Präsident des Europäischen Patentamts;
Im Auftrag

For the President of the European Patent Office

Le Président de l'Office européen des brevets
p.o.

R C van Dijk



PCT/EP200 4 / 0 5 3 6 0 6

Anmeldung Nr:
Application no.: 03104802.8
Demande no:

Anmeldetag:
Date of filing: 18.12.03
Date de dépôt:

Anmelder/Applicant(s)/Demandeur(s):

Tibotec Pharmaceuticals Ltd.
Unit 4, Block 4B, Blanchardstown Corporate
Park
Blanchardstown, Dublin 15
IRLANDE

Bezeichnung der Erfindung/Title of the invention/Titre de l'invention:
(Falls die Bezeichnung der Erfindung nicht angegeben ist, siehe Beschreibung.
If no title is shown please refer to the description.
Si aucun titre n'est indiqué se référer à la description.)

PIPERIDINE-AMINO-BENZIMIDAZOLE DERIVATIVES AS INHIBITORS OF RESPIRATORY SYNCYTIAL
VIRUS REPLICATION

In Anspruch genommene Priorität(en) / Priority(ies) claimed /Priorité(s)
revendiquée(s)
Staat/Tag/Aktenzeichen/State/Date/File no./Pays/Date/Numéro de dépôt:

Internationale Patentklassifikation/International Patent Classification/
Classification internationale des brevets:

C07D235/00

Am Anmeldetag benannte Vertragsstaaten/Contracting states designated at date of
filing/Etats contractants désignées lors du dépôt:

AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LU MC NL
PT RO SE SI SK TR LI

**PIPERIDINE-AMINO-BENZIMIDAZOLE DERIVATIVES AS INHIBITORS OF
RESPIRATORY SYNCYTIAL VIRUS REPLICATION**

5 The present invention is concerned with piperidine-amino-benzimidazole derivatives having antiviral activity, in particular, they have an inhibitory activity on the replication of the respiratory syncytial virus (RSV). It further concerns their preparation and compositions comprising them, as well as their use as a medicine.

10 Human RSV or Respiratory Syncytial Virus is a large RNA virus, member of the family of Paramyxoviridae, subfamily pneumovirinae together with bovine RSV virus. Human RSV is responsible for a spectrum of respiratory tract diseases in people of all ages throughout the world. It is the major cause of lower respiratory tract illness during infancy and childhood. Over half of all infants encounter RSV in their first year of life, and almost all within their first two years. The infection in young children can cause
15 lung damage that persists for years and may contribute to chronic lung disease in later life (chronic wheezing, asthma). Older children and adults often suffer from a (bad) common cold upon RSV infection. In old age, susceptibility again increases, and RSV has been implicated in a number of outbreaks of pneumonia in the aged resulting in significant mortality.

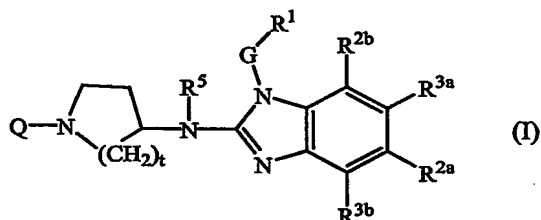
20 Infection with a virus from a given subgroup does not protect against a subsequent infection with an RSV isolate from the same subgroup in the following winter season. Re-infection with RSV is thus common, despite the existence of only two subtypes, A and B.

25 Today only three drugs have been approved for use against RSV infection. A first one is ribavirin, a nucleoside analogue, provides an aerosol treatment for serious RSV infection in hospitalized children. The aerosol route of administration, the toxicity (risk of teratogenicity), the cost and the highly variable efficacy limit its use. The other two
30 drugs, RespiGam® and palivizumab, polyclonal and monoclonal antibody immunostimulants, are intended to be used in a preventive way.

Other attempts to develop a safe and effective RSV vaccine have all met with failure thus far. Inactivated vaccines failed to protect against disease, and in fact in some cases
35 enhanced disease during subsequent infection. Live attenuated vaccines have been tried with limited success. Clearly there is a need for an efficacious non-toxic and easy to administer drug against RSV replication.

Previously, benzimidazoles and imidazopyridines as inhibitors of RSV replication have been described in WO 01/00611, WO 01/00612 and WO 01/00615.

5 The present invention now concerns inhibitors of RSV replication and are defined as the compounds of formula (I)

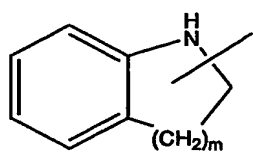


their prodrugs, *N*-oxides, addition salts, quaternary amines, metal complexes and stereochemically isomeric forms wherein

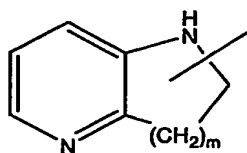
10 Q is C₁₋₆alkyl optionally substituted with one or more substituents each independently selected from the group consisting of trifluoromethyl, C₃₋₇cycloalkyl, Ar², hydroxy, C₁₋₄alkoxy, C₁₋₄alkylthio, Ar²-oxy-, Ar²-thio-, Ar²(CH₂)_noxy, Ar²(CH₂)_nthio, hydroxycarbonyl, aminocarbonyl, C₁₋₄alkylcarbonyl, Ar²carbonyl, C₁₋₄alkoxycarbonyl, Ar²(CH₂)_ncarbonyl, aminocarbonyloxy, C₁₋₄alkylcarbonyl-oxy, Ar²carbonyloxy, Ar²(CH₂)_ncarbonyloxy, C₁₋₄alkoxycarbonyl(CH₂)_noxy, 15 mono- or di(C₁₋₄alkyl)aminocarbonyl, mono- or di(C₁₋₄alkyl)aminocarbonyloxy, aminosulfonyl, mono- or di(C₁₋₄alkyl)aminosulfonyl or a heterocycles selected from the group consisting of pyrrolidinyl, pyrrolyl, dihydropyrrolyl, thiazolidinyl, imidazolyl, triazolyl, piperidinyl, homopiperidinyl, piperazinyl, morpholinyl, thiomorpholinyl, 1-oxo-thiomorpholinyl, 1,1-dioxothiomorpholinyl, pyridyl and 20 tetrahydropyridyl, wherein each of said heterocycle may optionally be substituted with oxo or C₁₋₆alkyl;

G is a direct bond or C₁₋₁₀alkanediyl optionally substituted with one or more substituents individually selected from the group consisting of hydroxy, C₁₋₆alkyloxy, Ar¹C₁₋₆alkyloxy, C₁₋₆alkylthio, Ar¹C₁₋₆alkylthio, 25 HO(-CH₂-CH₂-O)_n-, C₁₋₆alkyloxy(-CH₂-CH₂-O)_n- and Ar¹C₁₋₆alkyloxy(-CH₂-CH₂-O)_n-;

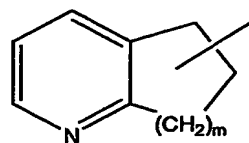
R¹ is Ar¹ or a monocyclic or bicyclic heterocycle being selected from piperidinyl, piperazinyl, pyridyl, pyrazinyl, pyridazinyl, pyrimidinyl, furanyl, tetrahydro-furanyl, thienyl, pyrrolyl, thiazolyl, oxazolyl, imidazolyl, isothiazolyl, pyrazolyl, 30 isoxazolyl, oxadiazolyl, quinolinyl, quinoxalinyl, benzofuranyl, benzothienyl, benzimidazolyl, benzoxazolyl, benzthiazolyl, pyridopyridyl, naphthiridinyl, 1*H*-imidazo[4,5-*b*]pyridinyl, 3*H*-imidazo[4,5-*b*]pyridinyl, imidazo[1,2-*a*]-pyridinyl, 2,3-dihydro-1,4-dioxino[2,3-*b*]pyridyl or a radical of formula



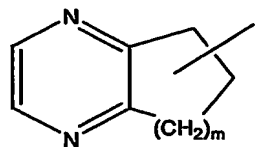
(c-1)



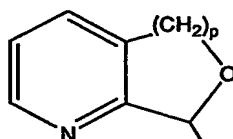
(c-2)



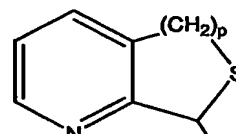
(c-3)



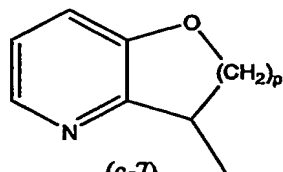
(c-4)



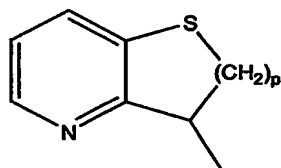
(c-5)



(c-6)



(c-7)



(c-8)

;

- wherein each of said monocyclic or bicyclic heterocycles may optionally be substituted with 1 or where possible more, such as 2, 3, 4 or 5, substituents individually selected from the group of substituents consisting of halo, hydroxy, amino, cyano, carboxyl, C₁₋₆alkyl, C₁₋₆alkyloxy, C₁₋₆alkylthio, C₁₋₆alkyloxyC₁₋₆alkyl, Ar¹, Ar¹C₁₋₆alkyl, Ar¹C₁₋₆alkyloxy, hydroxyC₁₋₆alkyl, mono- or di(C₁₋₆alkyl)amino, mono- or di(C₁₋₆alkyl)aminoC₁₋₆alkyl, polyhaloC₁₋₆alkyl, C₁₋₆alkylcarbonylamino, C₁₋₆alkyl-SO₂-NR^{4a}-, Ar¹-SO₂-NR^{4a}-, C₁₋₆alkyloxycarbonyl, -C(=O)-NR^{4a}R^{4b}, HO(-CH₂-CH₂-O)_n-, halo(-CH₂-CH₂-O)_n-, C₁₋₆alkyloxy(-CH₂-CH₂-O)_n-, Ar¹C₁₋₆alkyloxy(-CH₂-CH₂-O)_n- and mono- or di(C₁₋₆alkyl)amino(-CH₂-CH₂-O)_n-; each n independently is 1, 2, 3 or 4; one of R^{2a} and R^{3a} is C₁₋₆alkyl and the other one of R^{2a} and R^{3a} is hydrogen; in case R^{2a} is different from hydrogen then R^{2b} is hydrogen or C₁₋₆alkyl, and R^{3b} is hydrogen; in case R^{3a} is different from hydrogen then R^{3b} is hydrogen or C₁₋₆alkyl, and R^{2b} is hydrogen; R^{4a} and R^{4b} can be the same or can be different relative to one another, and are each independently hydrogen or C₁₋₆alkyl; or R^{4a} and R^{4b} taken together may form a bivalent radical of formula -(CH₂)_s-; R⁵ is hydrogen or C₁₋₆alkyl; m is 1 or 2; p is 1 or 2; s is 4 or 5;

t is 1, 2 or 3;

Ar¹ is phenyl or phenyl substituted with 1 or more, such as 2, 3 or 4, substituents selected from halo, hydroxy, C₁₋₆alkyl, hydroxyC₁₋₆alkyl, polyhaloC₁₋₆alkyl, and C₁₋₆alkyloxy;

- 5 Ar² is phenyl or phenyl substituted with 1 or more, such as 2, 3 or 4, substituents selected from the group consisting of halo, hydroxy, amino, cyano, C₁₋₆alkyl, hydroxyC₁₋₆alkyl, polyhaloC₁₋₆alkyl, aminoC₁₋₆alkyl, C₁₋₆alkyloxy, aminosulfonyl, aminocarbonyl, hydroxycarbonyl, C₁₋₄alkylcarbonyl, mono- or di(C₁₋₄alkyl)amino, mono- or di(C₁₋₄alkyl)aminocarbonyl, mono- or
10 di(C₁₋₄alkyl)aminosulfonyl, mono- or di(C₁₋₄alkyl)aminoC₁₋₆alkyl and C₁₋₄alkoxycarbonyl.

The term prodrug as used throughout this text means the pharmacologically acceptable derivatives, e.g. esters and amides, such that the resulting biotransformation product of
15 the derivative is the active drug as defined in the compounds of formula (I). The reference by Goodman and Gilman (The Pharmacological Basis of Therapeutics, 8th ed., McGraw-Hill, Int. Ed. 1992, "Biotransformation of Drugs", p. 13-15) describing prodrugs generally, is hereby incorporated. Prodrugs are characterized by a good aqueous solubility and bioavailability, and are readily metabolized into the active
20 inhibitors *in vivo*.

As used herein C₁₋₃alkyl as a group or part of a group defines straight or branched chain saturated hydrocarbon radicals having from 1 to 3 carbon atoms such as methyl, ethyl, propyl, 1-methylethyl and the like; C₁₋₄alkyl as a group or part of a group defines
25 straight or branched chain saturated hydrocarbon radicals having from 1 to 4 carbon atoms such as the group defined for C₁₋₃alkyl and butyl and the like; C₂₋₄alkyl as a group or part of a group defines straight or branched chain saturated hydrocarbon radicals having from 2 to 4 carbon atoms such as ethyl, propyl, 1-methylethyl, butyl and the like; C₁₋₆alkyl as a group or part of a group defines straight or branched chain
30 saturated hydrocarbon radicals having from 1 to 6 carbon atoms such as the groups defined for C₁₋₄alkyl and pentyl, hexyl, 2-methylbutyl and the like; C₁₋₉alkyl as a group or part of a group defines straight or branched chain saturated hydrocarbon radicals having from 1 to 9 carbon atoms such as the groups defined for C₁₋₆alkyl and heptyl, octyl, nonyl, 2-methylhexyl, 2-methylheptyl and the like; C₁₋₁₀alkyl as a group or part
35 of a group defines straight or branched chain saturated hydrocarbon radicals having from 1 to 10 carbon atoms such as the groups defined for C₁₋₉alkyl and decyl, 2-methylnonyl and the like.

C₃₋₇cycloalkyl is generic to cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl and cycloheptyl.

C₂₋₅alkanediyl defines bivalent straight and branched chain saturated hydrocarbon radicals having from 2 to 5 carbon atoms such as, for example, 1,2-ethanediyl, 1,3-propanediyl, 1,4-butanediyl, 1,2-propanediyl, 2,3-butanediyl, 1,5-pentanediyl and the like; C₁₋₄alkanediyl defines bivalent straight and branched chain saturated hydrocarbon radicals having from 1 to 4 carbon atoms such as, for example, methylene, 1,2-ethanediyl, 1,3-propanediyl, 1,4-butanediyl and the like; C₁₋₆alkanediyl is meant to include C₁₋₄alkanediyl and the higher homologues thereof having from 5 to 6 carbon atoms such as, for example, 1,5-pentanediyl, 1,6-hexanediyl and the like; C₁₋₁₀alkanediyl is meant to include C₁₋₆alkanediyl and the higher homologues thereof having from 7 to 10 carbon atoms such as, for example, 1,7-heptanediyl, 1,8-octanediyl, 1,9-nonanediyl, 1,10-decanediyl and the like.

As used herein before, the term (=O) forms a carbonyl moiety when attached to a carbon atom, a sulfoxide moiety when attached to a sulfur atom and a sulfonyl moiety when two of said terms are attached to a sulfur atom. The term (=N-OH) forms a hydroxylimine moiety when attached to a carbon atom.

The term halo is generic to fluoro, chloro, bromo and iodo. As used in the foregoing and hereinafter, polyhaloC₁₋₆alkyl as a group or part of a group is defined as mono- or polyhalosubstituted C₁₋₆alkyl, in particular methyl with one or more fluoro atoms, for example, difluoromethyl or trifluoromethyl. In case more than one halogen atoms are attached to an alkyl group within the definition of polyhaloC₁₋₄alkyl, they may be the same or different.

It should be noted that the radical positions on any molecular moiety used in the definitions may be anywhere on such moiety as long as it is chemically stable.

Radicals used in the definitions of the variables include all possible isomers unless otherwise indicated. For instance pyridyl includes 2-pyridyl, 3-pyridyl and 4-pyridyl; pentyl includes 1-pentyl, 2-pentyl and 3-pentyl.

When any variable occurs more than one time in any constituent, each definition is independent.

Whenever used hereinafter, the term "compounds of formula (I)", or "the present compounds" or similar term is meant to include the compounds of general formula (I),

their prodrugs, *N*-oxides, addition salts, quaternary amines, metal complexes and stereochemically isomeric forms. An interesting subgroup of the compounds of formula (I) or any subgroup thereof are the *N*-oxides, salts and all the stereoisomeric forms of the compounds of formula (I).

5

It will be appreciated that some of the compounds of formula (I) may contain one or more centers of chirality and exist as stereochemically isomeric forms.

10 The term "stereochemically isomeric forms" as used hereinbefore defines all the possible compounds made up of the same atoms bonded by the same sequence of bonds but having different three-dimensional structures which are not interchangeable, which the compounds of formula (I) may possess.

15 Unless otherwise mentioned or indicated, the chemical designation of a compound encompasses the mixture of all possible stereochemically isomeric forms which said compound may possess. Said mixture may contain all diastereomers and/or enantiomers of the basic molecular structure of said compound. All stereochemically isomeric forms of the compounds of the present invention both in pure form or in admixture with each other are intended to be embraced within the scope of the present invention.

20

Pure stereoisomeric forms of the compounds and intermediates as mentioned herein are defined as isomers substantially free of other enantiomeric or diastereomeric forms of the same basic molecular structure of said compounds or intermediates. In particular, the term 'stereoisomerically pure' concerns compounds or intermediates having a stereoisomeric excess of at least 80% (i. e. minimum 90% of one isomer and maximum 10% of the other possible isomers) up to a stereoisomeric excess of 100% (i.e. 100% of one isomer and none of the other), more in particular, compounds or intermediates having a stereoisomeric excess of 90% up to 100%, even more in particular having a stereoisomeric excess of 94% up to 100% and most in particular having a stereoisomeric excess of 97% up to 100%. The terms 'enantiomerically pure' and 'diastereomerically pure' should be understood in a similar way, but then having regard to the enantiomeric excess, respectively the diastereomeric excess of the mixture in question.

25

30 Pure stereoisomeric forms of the compounds and intermediates of this invention may be obtained by the application of art-known procedures. For instance, enantiomers may be separated from each other by the selective crystallization of their diastereomeric salts with optically active acids or bases. Examples thereof are tartaric acid, dibenzoyl-tartaric acid, ditoluoyltartaric acid and camphosulfonic acid. Alternatively, enantiomers

35

may be separated by chromatographic techniques using chiral stationary phases. Said pure stereochemically isomeric forms may also be derived from the corresponding pure stereochemically isomeric forms of the appropriate starting materials, provided that the reaction occurs stereospecifically. Preferably, if a specific stereoisomer is desired, said
5 compound will be synthesized by stereospecific methods of preparation. These methods will advantageously employ enantiomerically pure starting materials.

The diastereomeric racemates of formula (I) can be obtained separately by conventional methods. Appropriate physical separation methods that may advantageously be
10 employed are, for example, selective crystallization and chromatography, e.g. column chromatography.

For some of the compounds of formula (I), their prodrugs, N-oxides, salts, solvates, quaternary amines, or metal complexes and the intermediates used in the preparation
15 thereof, the absolute stereochemical configuration was not experimentally determined. A person skilled in the art is able to determine the absolute configuration of such compounds using art-known methods such as, for example, X-ray diffraction.

The present invention is also intended to include all isotopes of atoms occurring on the
20 present compounds. Isotopes include those atoms having the same atomic number but different mass numbers. By way of general example and without limitation, isotopes of hydrogen include tritium and deuterium. Isotopes of carbon include C-13 and C-14.

For therapeutic use, salts of the compounds of formula (I) are those wherein the
25 counterion is pharmaceutically acceptable. However, salts of acids and bases which are non-pharmaceutically acceptable may also find use, for example, in the preparation or purification of a pharmaceutically acceptable compound. All salts, whether pharmaceutically acceptable or not are included within the ambit of the present invention.

30 The pharmaceutically acceptable acid and base addition salts as mentioned hereinabove are meant to comprise the therapeutically active non-toxic acid and base addition salt forms which the compounds of formula (I) are able to form. The pharmaceutically acceptable acid addition salts can conveniently be obtained by treating the base form with such appropriate acid. Appropriate acids comprise, for example, inorganic acids
35 such as hydrohalic acids, e.g. hydrochloric or hydrobromic acid, sulfuric, nitric, phosphoric and the like acids; or organic acids such as, for example, acetic, propanoic, hydroxyacetic, lactic, pyruvic, oxalic (i.e. ethanedioic), malonic, succinic (i.e. butanedioic acid), maleic, fumaric, malic (i.e. hydroxybutanedioic acid), tartaric, citric,

methanesulfonic, ethanesulfonic, benzenesulfonic, *p*-toluenesulfonic, cyclamic, salicylic, *p*-aminosalicylic, pamoic and the like acids.

5 Conversely said salt forms can be converted by treatment with an appropriate base into the free base form.

10 The compounds of formula (I) containing an acidic proton may also be converted into their non-toxic metal or amine addition salt forms by treatment with appropriate organic and inorganic bases. Appropriate base salt forms comprise, for example, the ammonium salts, the alkali and earth alkaline metal salts, e.g. the lithium, sodium, potassium, magnesium, calcium salts and the like, salts with organic bases, e.g. the benzathine, *N*-methyl-D-glucamine, hydrabamine salts, and salts with amino acids such as, for example, arginine, lysine and the like.

15 The term addition salt as used hereinabove also comprises the solvates which the compounds of formula (I) as well as the salts thereof, are able to form. Such solvates are for example hydrates, alcoholates and the like.

20 The term "quaternary amine" as used hereinbefore defines the quaternary ammonium salts which the compounds of formula (I) are able to form by reaction between a basic nitrogen of a compound of formula (I) and an appropriate quaternizing agent, such as, for example, an optionally substituted alkylhalide, arylhalide or arylalkylhalide, e.g. methyl iodide or benzyl iodide. Other reactants with good leaving groups may also be used, such as alkyl trifluoromethanesulfonates, alkyl methanesulfonates, and alkyl *p*-toluenesulfonates. A quaternary amine has a positively charged nitrogen. Pharmaceutically acceptable counterions include chloro, bromo, iodo, trifluoroacetate and acetate. The counterion of choice can be introduced using ion exchange resins.

30 The *N*-oxide forms of the present compounds are meant to comprise the compounds of formula (I) wherein one or several nitrogen atoms are oxidized to the so-called *N*-oxide.

35 It will be appreciated that the compounds of formula (I) may have metal binding, chelating, complexing properties and therefore may exist as metal complexes or metal chelates. Such metalated derivatives of the compounds of formula (I) are intended to be included within the scope of the present invention.

Some of the compounds of formula (I) may also exist in their tautomeric form. Such forms although not explicitly indicated in the above formula are intended to be included within the scope of the present invention.

Interesting compounds are those compounds of formula (I) or any subgroup thereof wherein G is C₁₋₁₀alkanediyl; more in particular, G is methylene.

- 5 Other interesting compounds are those compounds of formula (I) or any subgroup thereof wherein R¹ is pyridyl optionally substituted with 1 or 2 substituents individually selected from the group of substituents consisting of halo, hydroxy, amino, cyano, carboxyl, C₁₋₆alkyl, C₁₋₆alkyloxy, C₁₋₆alkylthio, C₁₋₆alkyloxyC₁₋₆alkyl, Ar¹, Ar¹C₁₋₆alkyl, Ar¹C₁₋₆alkyloxy, hydroxyC₁₋₆alkyl, mono-or di(C₁₋₆alkyl)amino, mono-or
10 di(C₁₋₆alkyl)aminoC₁₋₆alkyl, polyhaloC₁₋₆alkyl, C₁₋₆alkylcarbonylamino, C₁₋₆alkyl-SO₂-NR^{4a}-, Ar¹-SO₂-NR^{4a}-, C₁₋₆alkyloxy carbonyl, -C(=O)-NR^{4a}R^{4b}, HO(-CH₂-CH₂-O)_n-, halo(-CH₂-CH₂-O)_n-, C₁₋₆alkyloxy(-CH₂-CH₂-O)_n-, Ar¹C₁₋₆alkyloxy(-CH₂-CH₂-O)_n- and mono-or di(C₁₋₆alkyl)amino(-CH₂-CH₂-O)_n-; more in particular R¹ is pyridyl substituted with hydroxy and C₁₋₆alkyl.

15

Other interesting compounds are those compounds of formula (I) wherein t is 2.

20

Preferred compounds are those compounds listed in tables 1 through 3, more in particular the compound numbers 1 to 10 and 17 to 31.

Compounds of formula (I) may be converted into each other following art-known functional group transformation reactions, comprising those described hereinafter.

25

The compounds of formula (I) may be converted to the corresponding *N*-oxide forms following art-known procedures for converting a trivalent nitrogen into its *N*-oxide form. Said *N*-oxidation reaction may generally be carried out by reacting the starting material of formula (I) with an appropriate organic or inorganic peroxide. Appropriate inorganic peroxides comprise, for example, hydrogen peroxide, alkali metal or earth alkaline metal peroxides, e.g. sodium peroxide, potassium peroxide; appropriate
30 organic peroxides may comprise peroxy acids such as, for example, benzenecarboperoxoic acid or halo substituted benzenecarboperoxoic acid, e.g. 3-chlorobenzenecarboperoxoic acid, peroxyalkanoic acids, e.g. peroxyacetic acid, alkylhydroperoxides, e.g. *t*-butyl hydro-peroxide. Suitable solvents are, for example, water, lower alcohols, e.g. ethanol and the like, hydrocarbons, e.g. toluene, ketones, e.g. 2-butanone, halogenated
35 hydrocarbons, e.g. dichloromethane, and mixtures of such solvents.

Pure stereochemically isomeric forms of the compounds of formula (I) may be obtained by the application of art-known procedures. Diastereomers may be separated by physical

methods such as selective crystallization and chromatographic techniques, e.g., counter-current distribution, liquid chromatography and the like.

5 The compounds of formula (I) as prepared in the hereinabove described processes are generally racemic mixtures of enantiomers which can be separated from one another following art-known resolution procedures. The racemic compounds of formula (I) which are sufficiently basic or acidic may be converted into the corresponding diastereomeric salt forms by reaction with a suitable chiral acid, respectively chiral base. Said diastereomeric salt forms are subsequently separated, for example, by selective or fractional crystallization and the enantiomers are liberated therefrom by alkali or acid. An alternative manner of separating the enantiomeric forms of the compounds of formula (I) involves liquid chromatography, in particular liquid chromatography using a chiral stationary phase. Said pure stereochemically isomeric forms may also be derived from the corresponding pure stereochemically isomeric forms of the appropriate starting materials, provided that the reaction occurs stereospecifically. Preferably if a specific stereoisomer is desired, said compound will be synthesized by stereospecific methods of preparation. These methods will advantageously employ enantiomerically pure starting materials.

20 The compounds of formula (I) show antiviral properties. Viral infections treatable using the compounds and methods of the present invention include those infections brought on by ortho- and paramyxoviruses and in particular by human and bovine respiratory syncytial virus (RSV).

25 The *in vitro* antiviral activity against RSV of the present compounds was tested in a test as described in the experimental part of the description, and may also be demonstrated in a virus yield reduction assay. The *in vivo* antiviral activity against RSV of the present compounds may be demonstrated in a test model using cotton rats as described in Wyde et al. (Antiviral Research (1998), 38, 31-42).

30 Due to their antiviral properties, particularly their anti-RSV properties, the compounds of formula (I) or any subgroup thereof, their prodrugs, *N*-oxides, addition salts, quaternary amines, metal complexes and stereochemically isomeric forms, are useful in the treatment of individuals experiencing a viral infection, particularly a RSV infection, and for the prophylaxis of these infections. In general, the compounds of the present invention may be useful in the treatment of warm-blooded animals infected with viruses, in particular the respiratory syncytial virus.

The compounds of the present invention or any subgroup thereof may therefore be used as medicines. Said use as a medicine or method of treatment comprises the systemic

administration to viral infected subjects or to subjects susceptible to viral infections of an amount effective to combat the conditions associated with the viral infection, in particular the RSV infection.

- 5 The present invention also relates to the use of the present compounds or any subgroup thereof in the manufacture of a medicament for the treatment or the prevention of viral infections, particularly RSV infection.

10 The compounds of the present invention or any subgroup thereof may be formulated into various pharmaceutical forms for administration purposes. As appropriate compositions there may be cited all compositions usually employed for systemically administering drugs. To prepare the pharmaceutical compositions of this invention, an effective amount of the particular compound, optionally in addition salt form or metal complex, as the active ingredient is combined in intimate admixture with a
15 pharmaceutically acceptable carrier, which carrier may take a wide variety of forms depending on the form of preparation desired for administration. These pharmaceutical compositions are desirable in unitary dosage form suitable, particularly, for administration orally, rectally, percutaneously, or by parenteral injection. For example, in preparing the compositions in oral dosage form, any of the usual pharmaceutical
20 media may be employed such as, for example, water, glycols, oils, alcohols and the like in the case of oral liquid preparations such as suspensions, syrups, elixirs, emulsions and solutions; or solid carriers such as starches, sugars, kaolin, lubricants, binders, disintegrating agents and the like in the case of powders, pills, capsules, and tablets. Because of their ease in administration, tablets and capsules represent the most
25 advantageous oral dosage unit forms, in which case solid pharmaceutical carriers are obviously employed. For parenteral compositions, the carrier will usually comprise sterile water, at least in large part, though other ingredients, for example, to aid solubility, may be included. Injectable solutions, for example, may be prepared in which the carrier comprises saline solution, glucose solution or a mixture of saline and
30 glucose solution. Injectable suspensions may also be prepared in which case appropriate liquid carriers, suspending agents and the like may be employed. Also included are solid form preparations which are intended to be converted, shortly before use, to liquid form preparations. In the compositions suitable for percutaneous administration, the carrier optionally comprises a penetration enhancing agent and/or a
35 suitable wetting agent, optionally combined with suitable additives of any nature in minor proportions, which additives do not introduce a significant deleterious effect on the skin.

The compounds of the present invention may also be administered via oral inhalation or insufflation by means of methods and formulations employed in the art for administration via this way. Thus, in general the compounds of the present invention may be administered to the lungs in the form of a solution, a suspension or a dry powder, a solution being preferred. Any system developed for the delivery of solutions, suspensions or dry powders via oral inhalation or insufflation are suitable for the administration of the present compounds.

Thus, the present invention also provides a pharmaceutical composition adapted for administration by inhalation or insufflation through the mouth comprising a compound of formula (I) and a pharmaceutically acceptable carrier. Preferably, the compounds of the present invention are administered via inhalation of a solution in nebulized or aerosolized doses.

It is especially advantageous to formulate the aforementioned pharmaceutical compositions in unit dosage form for ease of administration and uniformity of dosage. Unit dosage form as used herein refers to physically discrete units suitable as unitary dosages, each unit containing a predetermined quantity of active ingredient calculated to produce the desired therapeutic effect in association with the required pharmaceutical carrier. Examples of such unit dosage forms are tablets (including scored or coated tablets), capsules, pills, suppositories, powder packets, wafers, injectable solutions or suspensions and the like, and segregated multiples thereof.

In general it is contemplated that an antivirally effective daily amount would be from 0.01 mg/kg to 500 mg/kg body weight, more preferably from 0.1 mg/kg to 50 mg/kg body weight. It may be appropriate to administer the required dose as two, three, four or more sub-doses at appropriate intervals throughout the day. Said sub-doses may be formulated as unit dosage forms, for example, containing 1 to 1000 mg, and in particular 5 to 200 mg of active ingredient per unit dosage form.

The exact dosage and frequency of administration depends on the particular compound of formula (I) used, the particular condition being treated, the severity of the condition being treated, the age, weight, sex, extent of disorder and general physical condition of the particular patient as well as other medication the individual may be taking, as is well known to those skilled in the art. Furthermore, it is evident that said effective daily amount may be lowered or increased depending on the response of the treated subject and/or depending on the evaluation of the physician prescribing the compounds of the instant invention. The effective daily amount ranges mentioned hereinabove are therefore only guidelines.

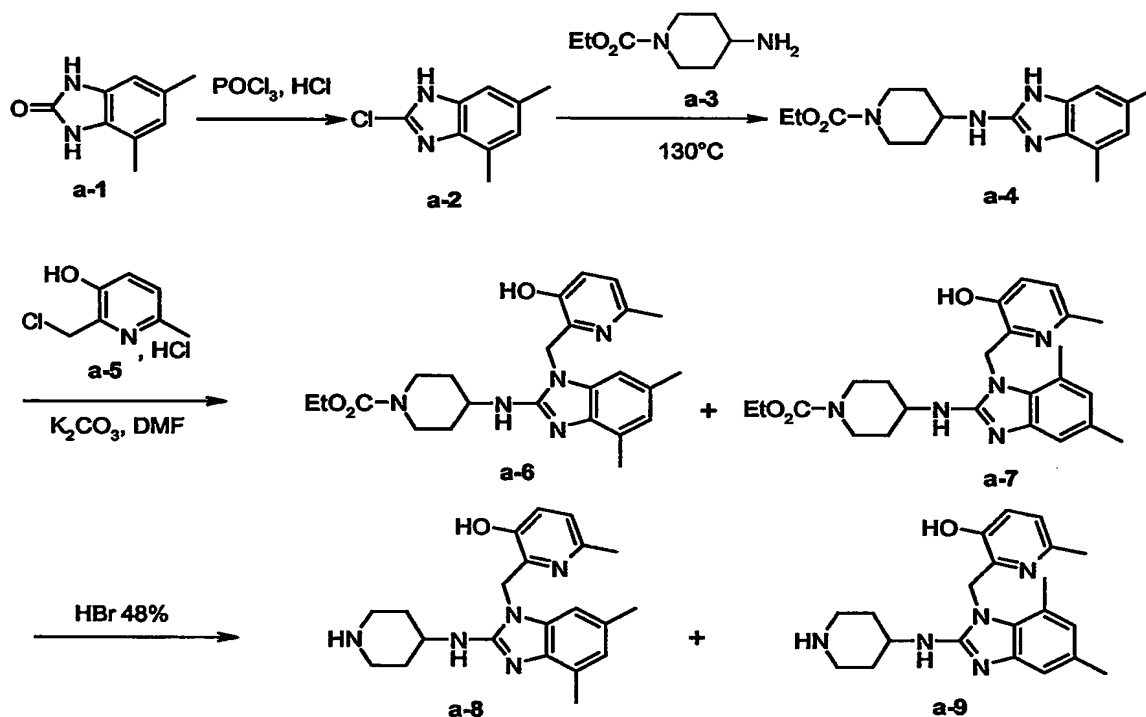
Also, the combination of another antiviral agent and a compound of formula (I) can be used as a medicine. Thus, the present invention also relates to a product containing (a) a compound of formula (I), and (b) another antiviral compound, as a combined preparation for simultaneous, separate or sequential use in antiviral treatment. The different drugs may be combined in a single preparation together with pharmaceutically acceptable carriers. For instance, the compounds of the present invention may be combined with interferon-beta or tumor necrosis factor-alpha in order to treat or prevent RSV infections.

Experimental Part

The following examples are intended to illustrate the present invention.

A. Chemical synthesis of the compounds of formula (I)

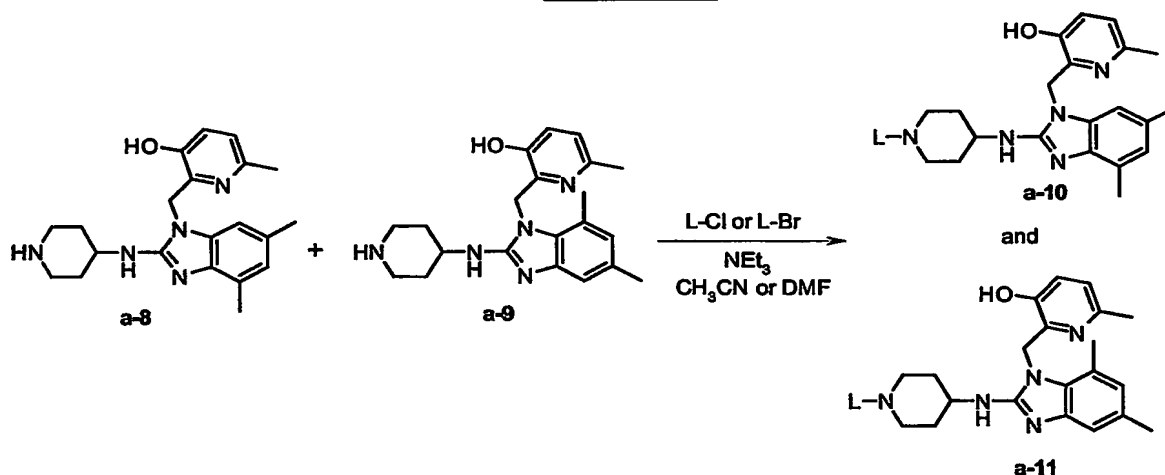
Scheme A-1



- a) The mixture of a-1 (0.06 mol) and POCl_3 (100 ml) was heated at 100°C and HCl 12N (2.5 ml) was added drop wise very carefully. The reaction was then stirred during 12 hours at 120°C and allowed to cool down to room temperature. The solvent was evaporated under reduced pressure and a 10% solution of potassium carbonate in water was added to the residue. The resulting precipitate was filtered off, rinsed with water and dried, yielding 10 g of a-2 (93%, melting point = 152°C).

- b) **a-2** (0.022 mol) and **a-3** (0.088 mol) were stirred at 130°C during 12 hours. The reaction was then allowed to cool down to room temperature, the residue was taken up in acetone and the precipitate was filtered off. The acetone solution was concentrated under reduced pressure. The residue was purified by column chromatography over silica gel (eluent: CH₂Cl₂/MeOH/NH₄OH 95/5/0.1). The pure fractions were collected and the solvent was evaporated, yielding 5 g of **a-4** (72%).
- c) A mixture of **a-4** (0.0158 mol), **a-5** (0.019 mol) and potassium carbonate (0.0553 mol) in dimethylformamide (100ml) was stirred at 70°C for 24 hours. The solvent was evaporated till dryness. The residue was taken up in CH₂Cl₂/CH₃OH (90/10). The organic layer was washed with a 10% solution of K₂CO₃ in water, dried (over MgSO₄), filtered and the solvent was evaporated under reduced pressure. The residue was taken up in 2-propanone. The precipitate was filtered off, washed with H₂O and dried, yielding 5g of **a-6** and **a-7** (50/50 mixture, 73%).
- d) A mixture of **a-6** and **a-7** (0.0103 mol) in a 48% solution of HBr in water (50ml) was stirred at 60°C during 12 hours. The solvent was evaporated till dryness. The residue was taken up in CH₂Cl₂/CH₃OH (90/10). 10% solution of K₂CO₃ in water was added. The aqueous layer was saturated with K₂CO₃ (powder). The organic layer was separated, dried (over MgSO₄), filtered, and the solvent was evaporated till dryness, yielding 3.7g of **a-8** and **a-9** (100%). This product was used directly in the next reaction step.

Scheme A-2:



Pathway 1:

- A mixture of **a-8** (0.0002 mol), **a-9** (0.0002 mol), 2-bromo-ethanol (0.0006 mol) and triethylamine (0.0011 mol) in acetonitrile (10ml) was stirred at 30°C for 12 hours. The solvent was evaporated till dryness. The residue was taken up in CH₂Cl₂. The organic layer was washed with H₂O, dried (over MgSO₄), filtered, and the solvent was

evaporated. The residue was purified by column chromatography over silica gel (eluent: CH₂Cl₂/CH₃OH/NH₄OH 85/15/1; 10μm). Two fractions were collected and the solvent was evaporated, yielding: 0.028g fraction 1 (12.4%) and 0.05g fraction 2 (22%). Fraction 1 was crystallized from 2-propanone/diisopropylether. The precipitate was filtered off and dried, yielding 0.015g of 2-{2-[1-(2-hydroxy-ethyl)-piperidin-4-ylamino]-5,7-dimethyl-benzoimidazol-1-ylmethyl}-6-methyl-pyridin-3-ol (6.6%, melting point: 143°C). Fraction 2 was crystallized from 2-propanone/diisopropylether. The precipitate was filtered off and dried, yielding 0.03g of 2-{2-[1-(2-hydroxy-ethyl)-piperidin-4-ylamino]-4,6-dimethyl-benzoimidazol-1-ylmethyl}-6-methyl-pyridin-3-ol (13%, melting point: 177°C).

Pathway 2:

A mixture of a-8 (0.0008 mol), a-9 (0.0008 mol), 3-chloro-propane-sulfonamide (0.0019 mol) and triethylamine (0.0024 mol) in dimethylformamide (50ml) was stirred at 70°C for 12 hours, then poured out into H₂O and extracted with CH₂Cl₂. The organic layer was separated, dried (over MgSO₄), filtered and the solvent was evaporated till dryness. The residue (1g) was purified by column chromatography over silica gel (eluent: CH₂Cl₂/CH₃OH/NH₄OH 90/10/0.5; 15-40μm). The pure fractions were collected and the solvent was evaporated, yielding 0.12g of 3-{4-[1-(3-hydroxy-6-methyl-pyridin-2-ylmethyl)-4,6-dimethyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-propane-1-sulfonic acid amide (15%) (melting point: 180°C).

Pathway 3

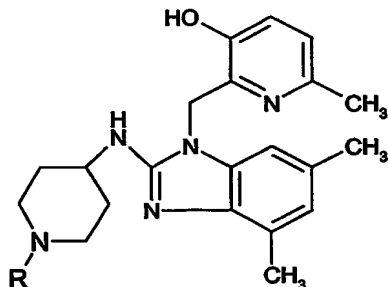
LiAlH₄ (0.0002 mol) was added at 5°C to a mixture of 3-{4-[1-(3-Hydroxy-6-methyl-pyridin-2-ylmethyl)-4,6-dimethyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-propionic acid ethyl ester (0.00009 mol; melting point: 172°C; prepared according to the procedure described in pathway 2) in tetrahydrofuran (10ml) under N₂ flow. The mixture was stirred at 5°C for 1 hour, then at room temperature for 3 hours. A minimum of H₂O and ethylacetate were added. The organic layer was separated, dried (over MgSO₄), filtered and the solvent was evaporated till dryness. The residue was crystallized from 2-propanone/CH₃CN/diisopropylether. The precipitate was filtered off and dried, yielding 0.026g of 2-{2-[1-(3-hydroxy-propyl)-piperidin-4-ylamino]-4,6-dimethyl-benzoimidazol-1-ylmethyl}-6-methyl-pyridin-3-ol (68%, melting point: 209°C).

Pathway 4

A mixture of 3-{4-[1-(3-Hydroxy-6-methyl-pyridin-2-ylmethyl)-4,6-dimethyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-propionic acid ethyl ester (0.0065 mol) in methanol/NH₃ 7N (15ml) was stirred in a sealed vessel at 70°C for 12 hours. The solvent was evaporated till dryness. The residue (0.3g) was purified by column

chromatography over silica gel (eluent: CH₂Cl₂/CH₃OH/NH₄OH 85/14/1; 5μm). The pure fractions were collected and the solvent was evaporated. The residue (0.09g, 32%) was crystallized from diisopropylether. The precipitate was filtered off and dried, yielding 0.086g of 3-{4-[1-(3-hydroxy-6-methyl-pyridin-2-ylmethyl)-4,6-dimethyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-propionamide (30%, melting point: 212°C).

Table 1 – compounds prepared according to scheme A



Comp. No.	-R	Activity category	Mass Spectroscopy	Melting point	pathway
1		A	MH ⁺ = 487	180°C	2
2		A	MH ⁺ = 410	177°C	1
3		A	MH ⁺ = 473	242°C	2
4		A	MH ⁺ = 424	209°C	3
5		8.1 A	MH ⁺ = 437	212°C	4
6		A	MH ⁺ = 501	179°C	2
7		A	MH ⁺ = 451	186°C	4
8		A	MH ⁺ = 438	206°C	3
9		A	MH ⁺ = 451	206°C	4
10		A	MH ⁺ = 466	172°C	2
11		B	MH ⁺ = 423	226°C	4

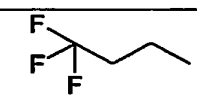
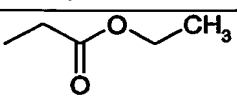
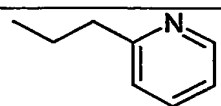
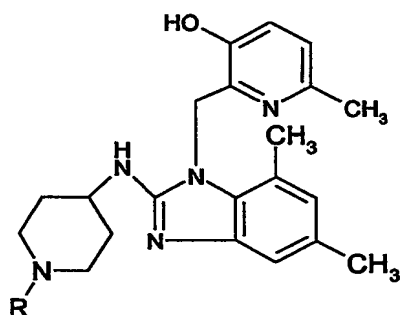
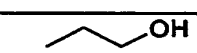
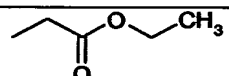
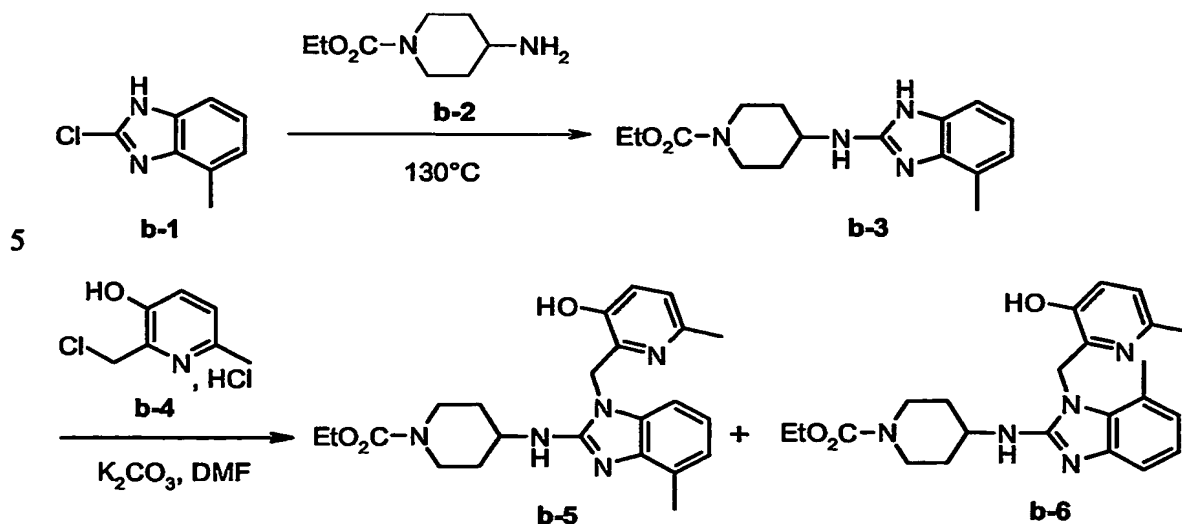
Comp. No.	-R	Activity category	Mass Spectroscopy	Melting point	pathway
12		B	$MH^+ = 462$	$>260^\circ C$	2
13		B	$MH^+ = 452$	$186^\circ C$	1
14		B	$MH^+ = 471$	$161^\circ C$	2

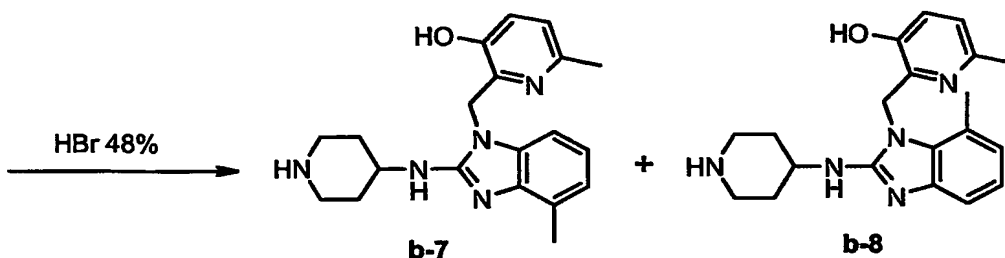
Table 2 – compounds prepared according to scheme 2



Comp. No.	R	Activity category	Mass Spectroscopy	Melting point	pathway
15		B	$MH^+ = 410$	$143^\circ C$	1
16		C	$MH^+ = 452$	$186^\circ C$	2

Scheme B-1

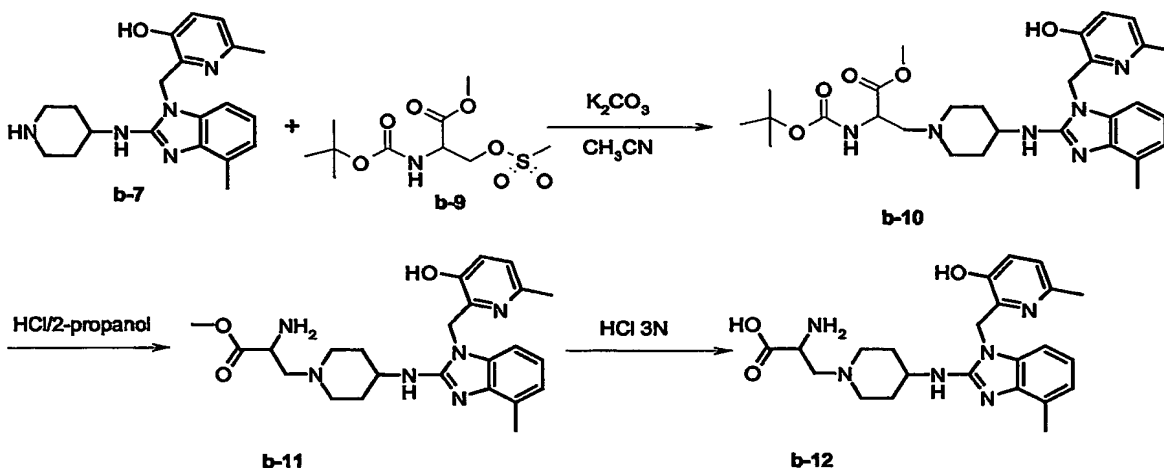




- a) The preparation of this intermediate **b-3** is analogous to the preparation of intermediate **a-4**.
- b) The preparation of these intermediates **b-5** and **b-6** is analogous to the preparation of intermediates **a-6** and **a-7**.
- c) The preparation of these intermediates **b-7** and **b-8** is analogous to the preparation of intermediates **a-8** and **a-8**. Further to that, **b-7** has been isolated pure after crystallization with diisopropylether (melting point: > 260°C).

Scheme B-2

Pathway 1

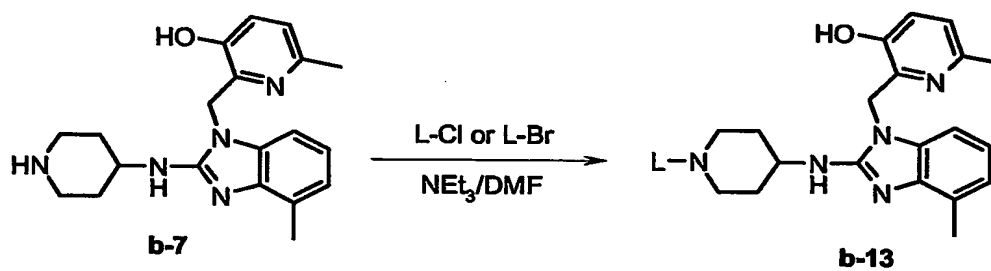


- a) A mixture of **b-7** (0.0056 mol), **b-9** (0.0113 mol) and K_2CO_3 (0.0171 mol) in CH_3CN (30ml) was stirred and refluxed for 6 hours. The solvent was evaporated. The residue was taken up in CH_2Cl_2 and washed with a saturated solution of NaCl in water. The organic layer was separated, dried (over MgSO_4), filtered and the solvent was evaporated. The residue (2.4g) was purified by column chromatography over silica gel (eluent: $\text{CH}_2\text{Cl}_2/\text{CH}_3\text{OH}/\text{NH}_4\text{OH}$ 95/5/0.2; 15-40 μm). The pure fractions were collected and the solvent was evaporated, yielding 1g of intermediate **b-10** (32%).
- b) A saturated solution of HCl in 2-propanol (1.5ml) was added at room temperature to a mixture of **b-10** (0.0013 mol) in 2-propanol (15ml). The mixture was stirred at

60°C for 12 hours, and then cooled to room temperature. The precipitate was filtered, washed with 2-propanol, then with diethyl ether and dried, yielding 0.79g. This fraction was crystallized from 2-propanol. The precipitate was filtered, washed with diethyl ether and dried, yielding 0.11g of **b-11** (14%).

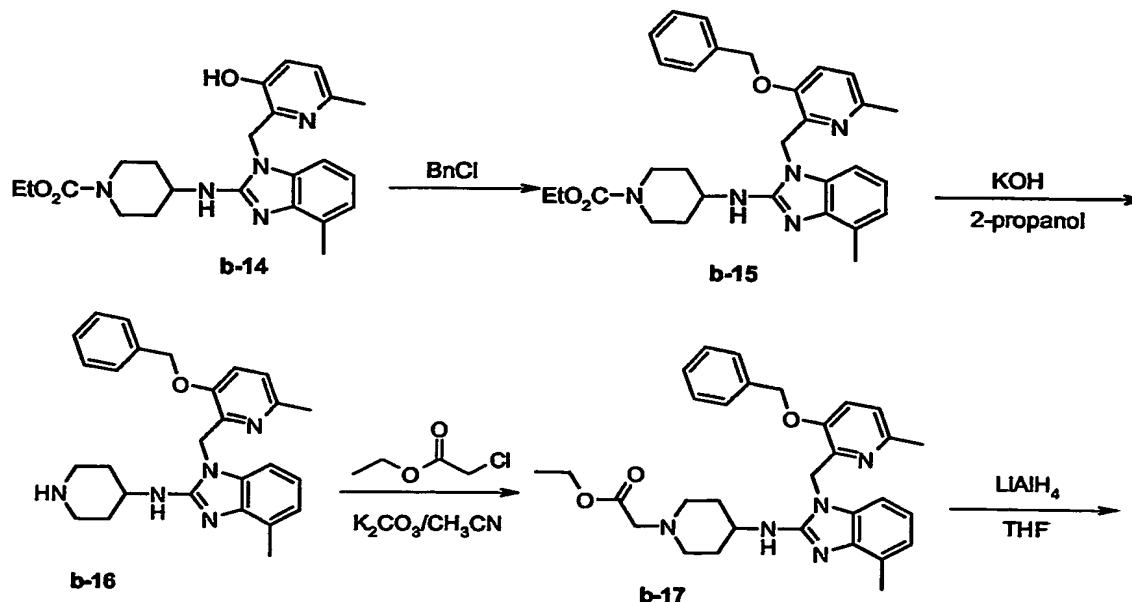
- 5 c) A mixture of **b-11** (0.0011 mol) in a 3N solution of HCl in water (5ml) was stirred and refluxed for 6 hours, then cooled to room temperature and the solvent was evaporated. The residue (0.4g) was purified by column chromatography over silica gel (eluent: CH₂Cl₂/CH₃OH/NH₄OH 70/30/3; 15-40μm). Two fractions were collected and the solvent was evaporated. Yielding: 0.111g. This fraction was
10 crystallized from ethanol. The precipitate was filtered off and dried, yielding 0.03g of **b-12** (5%, melting point: 195°C).

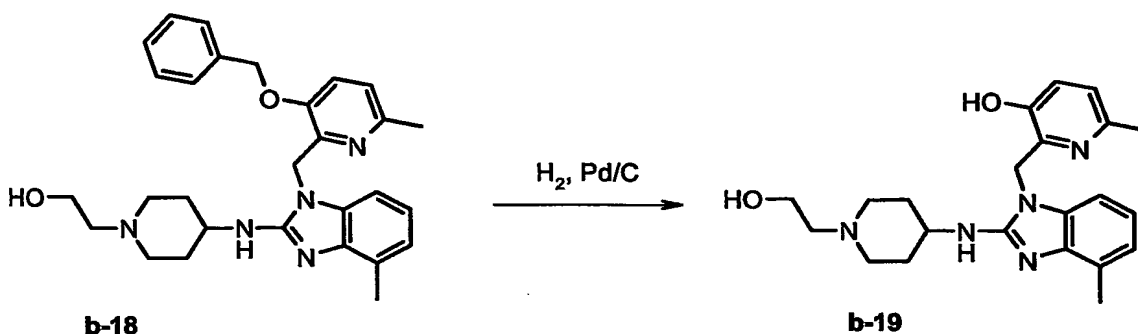
Pathway 2:



- 15 3-[4-[1-(3-hydroxy-6-methyl-pyridin-2-ylmethyl)-4,6-dimethyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl]-propane-1-sulfonic acid amide (melting point: 250°C) was prepared analogous to the procedure described in pathway 2, scheme A-2.

Pathway 3:

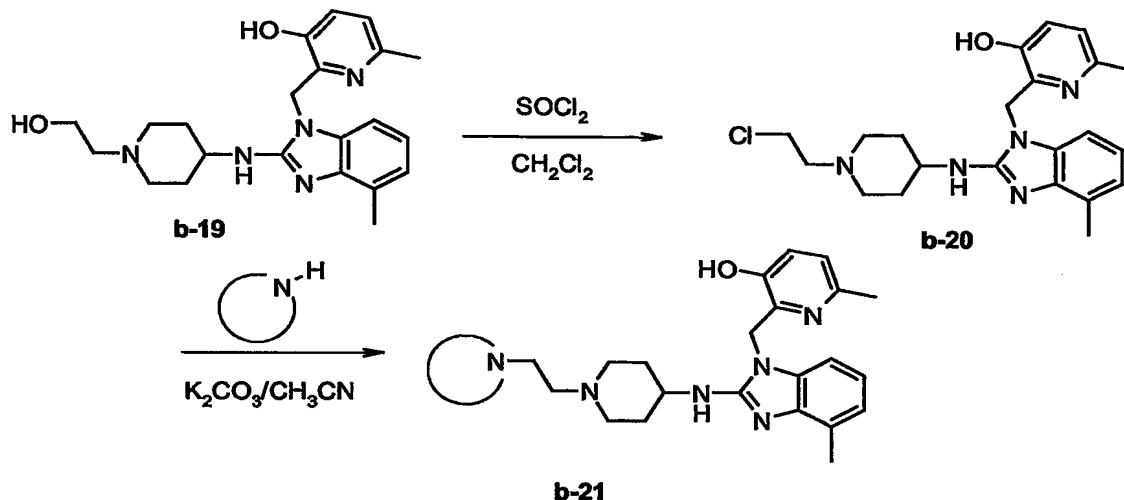




- a) A mixture of **b-14** (0.0236 mol), benzyl bromide (0.026 mol) and K_2CO_3 (0.0354 mol) in a mixture of CH_3CN (50ml), dimethylformamide (50ml) and tetrahydrofuran (100ml) was stirred at 60°C for 24 hours. The solvent was evaporated till dryness. The residue was taken up in H_2O . The precipitate was filtered, washed with H_2O and extracted with diethyl ether. The organic layer was separated, dried (over MgSO_4), filtered and the solvent was evaporated till dryness. The residue (12g) was purified by column chromatography over silica gel (eluent: $\text{CH}_2\text{Cl}_2/\text{CH}_3\text{OH}/\text{NH}_4\text{OH}$ 98/2/0.1; 15-40 μm). Three fractions were collected and the solvent was evaporated, yielding 5g of **b-15** (41.3%).
- b) A mixture of **b-15** (0.0095 mol) and KOH (0.0095 mol) in 2-propanol (60ml) was stirred and refluxed for 4 hours. The solvent was evaporated till dryness. The residue was taken up in CH_2Cl_2 . The organic layer was washed with H_2O , dried (over MgSO_4), filtered and the solvent was evaporated till dryness, yielding 5g of **b-16** (>100%, melting point: 182°C). The product was used directly in the next reaction step.
- c) A mixture of **b-16** (0.0307 mol), ethyl chloro-acetate (0.037 mol) and K_2CO_3 (0.046 mol) in CH_3CN (150ml) was stirred at 60°C for 12 hours. The solvent was evaporated till dryness. The residue was taken up in CH_2Cl_2 . The organic layer was washed with H_2O , dried (over MgSO_4), filtered and the solvent was evaporated till dryness. The residue was crystallized from 2-propanone/ CH_3CN . The precipitate was filtered off and dried, yielding 14.5g of **b-17** (89.5%, melting point: 116°C).
- d) LiAlH_4 (0.047 mol) was added portion wise at 5°C to a mixture of **b-17** (0.023 mol) in tetrahydrofuran (250ml) under N_2 flow. The mixture was stirred at 5°C for 2 hours. H_2O was added. The mixture was extracted with ethylacetate and filtered over celite. The organic layer was separated, dried (over MgSO_4), filtered and the solvent was evaporated till dryness, yielding 8g of **b-18** (71.6%, melting point: 159°C).
- e) A mixture of **b-18** (0.0004 mol) and Pd/C (0.1g) in CH_3OH (20ml) was hydrogenated at 40°C for 3 hours under a 5 bar pressure, then cooled and filtered over celite. The filtrate was evaporated till dryness, yielding 0.16g residue (100%).

This fraction was crystallized from 2-propanone/diisopropylether. The precipitate was filtered off and dried, yielding 0.07g of **b-19** (43%, melting point: 258°C).

Pathway 4:



- 5 a) SOCl_2 (0.0214 mol) was added drop wise to a solution of **b-19** in CH_2Cl_2 at 0°C. The reaction was stirred at room temperature for 5 hours. The precipitate was filtered off, rinsed with diisopropylether and dried, yielding **b-20** (100%). The crude compound was used in the next reaction step.
- 10 b) A mixture of **b-20** (0.0011 mol), K_2CO_3 (0.0038 mol) and pyrrolidine (0.0013 mol) in CH_3CN (10ml) was stirred at 70°C for 12 hours. H_2O was added. The mixture was extracted with CH_2Cl_2 . The organic layer was separated, dried (over MgSO_4), filtered and the solvent was evaporated. The residue (0.27g) was purified by column chromatography over silica gel (eluent: $\text{CH}_2\text{Cl}_2/\text{CH}_3\text{OH}/\text{NH}_4\text{OH}$ 88/11/1; 10 μm). The pure fractions were collected and the solvent was evaporated. The residue (0.14g) was crystallized from $\text{CH}_3\text{CN}/2$ -propanone. The precipitate was filtered off and dried, yielding 0.105g of 6-Methyl-2-{4-methyl-2-[1-(2-pyrrolidin-1-yl-ethyl)-piperidin-4-ylamino]-benzoimidazol-1-ylmethyl}-pyridin-3-ol (28%, melting point: 225°C).

Pathway 5

- 20 a) 3-{4-[1-(3-Hydroxy-6-methyl-pyridin-2-ylmethyl)-4-methyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-propionic acid ethyl ester (melting point: 226°C) was prepared analogous to the procedure described for the preparation of **b-19**.
- 25 b) 3-{4-[1-(3-Hydroxy-6-methyl-pyridin-2-ylmethyl)-4-methyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-propionamide (melting point: 258°C) was prepared according to the procedure described in pathway 4, scheme A-2.

Pathway 6

- a) A mixture of **b-18** (0.002 mol), phenyl-acetic acid (0.0024 mol), DCC (0.0029 mol) and DMAP (0.0029 mol) in THF (50ml) was stirred at room temperature for 12 hours. H₂O was added. The mixture was extracted with ethylacetate and filtered. The organic layer was separated, dried (over MgSO₄), filtered and the solvent was evaporated till dryness. The residue (1.5g) was purified by column chromatography over silica gel (eluent: CH₂Cl₂/CH₃OH/NH₄OH 96/4/0.1; 15-35 μ m). The pure fractions were collected and the solvent was evaporated. The residue (1.2g, 96%) was crystallized from diisopropylether. The precipitate was filtered off and dried, yielding 0.8g of propionic acid 2-{4-[1-(3-hydroxy-6-methyl-pyridin-2-ylmethyl)-4-methyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-ethyl ester (64%, melting point: 105°C).
- b) Phenyl-acetic acid 2-{4-[1-(3-hydroxy-6-methyl-pyridin-2-ylmethyl)-4-methyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-ethyl ester (melting point: 207°C) was prepared analogous to the procedure described for **b-19**.

Pathway 7:

- a) A mixture of 3-{4-[1-(3-Hydroxy-6-methyl-pyridin-2-ylmethyl)-4-methyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-propionic acid ethyl ester (0.0009 mol) in a 3N solution of HCl in water (5ml) was stirred and refluxed for 18 hours and then cooled to room temperature. The precipitate was filtered, washed with diethyl ether and dried, yielding 0.18g of 3-{4-[1-(3-hydroxy-6-methyl-pyridin-2-ylmethyl)-4-methyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-propionic acid hydrochloride salt (31%, melting point: 245°C).

Pathway 8:

- a) 1-{4-[1-(3-Hydroxy-6-methyl-pyridin-2-ylmethyl)-4-methyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-3-methyl-butan-2-one was prepared analogous to the procedure described for **b-19**.
- b) NaBH₄ (0.0003 mol) was added portion wise to a solution of 1-{4-[1-(3-Hydroxy-6-methyl-pyridin-2-ylmethyl)-4-methyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-3-methyl-butan-2-one (0.0002 mol) in tetrahydrofuran (2ml) and CH₃OH (2ml) at 5°C. The mixture was stirred at room temperature for 4 hours. 10% solution of K₂CO₃ in water was added. The mixture was extracted with CH₂Cl₂. The organic layer was washed with H₂O, dried (over MgSO₄), filtered and the solvent was evaporated. The residue (0.08g) was dissolved in CH₂Cl₂/CH₃OH and crystallized from diisopropylether. The precipitate was filtered, washed with diisopropylether and dried, yielding 0.049g of 2-{2-[1-(2-hydroxy-3-methyl-butyl)-piperidin-4-

ylamino]-4-methyl-benzoimidazol-1-ylmethyl}-6-methyl-pyridin-3-ol (48%, melting point: 230°C).

Pathway 9:

- a) Chlorosulfonyl isocyanate (0.0021 mol) was added at -30°C to a mixture of **b-18** (0.0009 mol) in ethylacetate (15ml) under N₂ flow. The mixture was stirred at -30°C for 1 hour, then brought to 0°C. H₂O (0.5ml), HCl 12N (0.5ml) then CH₃OH (1ml) was added. The mixture was stirred at 40°C for 1 hour, then cooled, basified with K₂CO₃ and extracted with ethylacetate. The organic layer was separated, dried (over MgSO₄), filtered and the solvent was evaporated till dryness, yielding 0.46g of carbamic acid 2-{4-[1-(3-benzyloxy-6-methyl-pyridin-2-ylmethyl)-4-methyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-ethyl ester (94%, melting point:).
- b) Carbamic acid 2-{4-[1-(3-hydroxy-6-methyl-pyridin-2-ylmethyl)-4-methyl-1H-benzoimidazol-2-ylamino]-piperidin-1-yl}-ethyl ester (melting point: 222°C) has been prepared analogous to the procedure described for **b-19**.

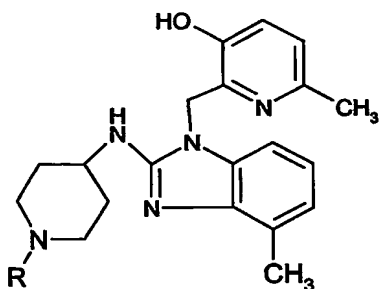
Pathway 10:

- A mixture of **b-7** (0.0014 mol), glycidyl 4-methoxyphenyl ether (0.0021 mol) in ethanol (10ml) was stirred and refluxed for 4 hours, then cooled to room temperature and the solvent was evaporated. The residue (0.75g) was purified by column chromatography over silica gel (eluent: CH₂Cl₂/CH₃OH 90/10; 15-40µm). The pure fractions were collected and the solvent was evaporated, yielding 0.101g of 2-(2-{1-[2-hydroxy-3-(4-methoxy-phenoxy)-propyl]-piperidin-4-ylamino}-4-methyl-benzoimidazol-1-ylmethyl)-6-methyl-pyridin-3-ol (13%, melting point: 227°C).

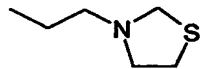
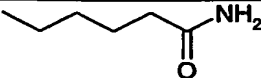
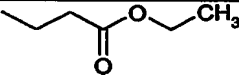
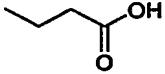

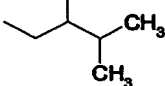
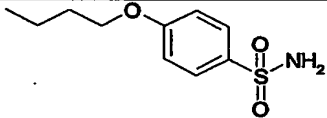
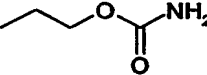
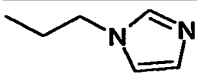
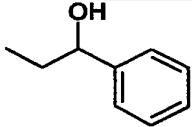
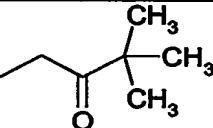
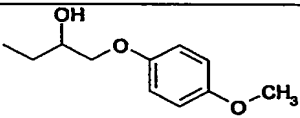
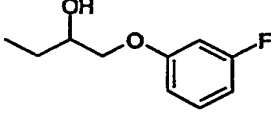
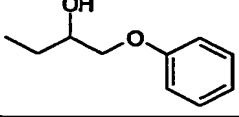
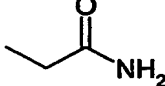
Pathway 11:

- Formaldehyde 37% in water (0.0017 mol) and NaBH₃CN (0.001 mol) were added at room temperature to a mixture of **b-7** (0.0008 mol) in CH₃CN (1ml). Acetic acid (0.3ml) was added drop wise. The mixture was stirred at room temperature overnight. The solvent was evaporated till dryness. ethanol (3ml) and a saturated solution of HCl in 2-propanol (1ml) were added. The mixture was stirred at 80°C for 2 hours, basified with K₂CO₃ 10% in water and extracted with CH₂Cl₂. The organic layer was separated, dried (over MgSO₄), filtered and the solvent was evaporated. The residue (0.21g) was purified by column chromatography over silica gel (eluent: CH₂Cl₂/CH₃OH/NH₄OH 90/10/0.1 to 80/20/3; 35-70µm). The pure fractions were collected and the solvent was evaporated till dryness, yielding 0.1g of 6-methyl-2-[4-methyl-2-(1-methyl-piperidin-4-ylamino)-benzoimidazol-1-ylmethyl]-pyridin-3-ol (32%, melting point: 210°C).

Table 3 – compounds prepared according to Scheme B



Comp. No.	R	Activity category	Mass Spectroscopy	Melting point	Pathway	Salt
17		A	MH ⁺ = 452	210°C	1	HCl
18		A	MH ⁺ = 449	225°C	4	
19		A	MH ⁺ = 473	250°C	2	
20		A	MH ⁺ = 426	240°C	2	
21		A	MH ⁺ = 461	—	4	
22		A	MH ⁺ = 396	258°C	3	
23		A	MH ⁺ = 437	195°C	1	HCl
24		A	MH ⁺ = 514	207°C	6	
25		A	MH ⁺ = 477		4	
26		A	MH ⁺ = 447		4	
27		A	MH ⁺ = 423	258°C	5	
28		A	MH ⁺ = 487	217°C	2	
29		A	MH ⁺ = 424	>260°C	3	

Comp. No.	R	Activity category	Mass Spectroscopy	Melting point	Pathway	Salt
30		A	MH ⁺ = 467		4	
31		A	MH ⁺ = 451	220°C	2	
32		B	MH ⁺ = 452	226°C	2	
33		B	MH ⁻ = 422	245°C	7	HCl
34		B	MH ⁺ = 466	210°C	11	
35		B	MH ⁺ = 438	230°C	8	
36		B	MH ⁺ = 565	>260°C	2	
37		B	MH ⁺ = 439	222°C	9	
38		B	MH ⁺ = 446		4	
39		B	MH ⁺ = 472	229°C	8	
40		B	MH ⁺ = 450	230°C	3	
41		B	MH ⁺ = 532	227°C	10	
42		B	MH ⁺ = 520	230°C	10	
43		B	MH ⁺ = 502	228°C	10	
44		B	MH ⁺ = 409	254°C	5	

Comp. No.	R	Activity category	Mass Spectroscopy	Melting point	Pathway	Salt
45		B	MH ⁺ = 486	158°C	10	
46		B	MH ⁺ = 447		4	
47		B	MH ⁺ = 558	228°C	2	
48		B	MH ⁺ = 422	230°C	3	
49		B	MH ⁺ = 436		3	
50		B	MH ⁺ = 452	255°C	8	
51		C	MH ⁺ = 468	105°C	6	
52		C	MH ⁺ = 558	196°C	2	
53		C	MH ⁺ = 438	159°C	3	
54		C	MH ⁺ = 464	>260°C	10	
55		C	MH ⁻ = 408	205°C	7	HCl

B. In vitro screening for activity against Respiratory Syncytial Virus.

5 The percent protection against cytopathology caused by viruses (antiviral activity or IC₅₀) achieved by tested compounds and their cytotoxicity (CC₅₀) are both calculated from dose-response curves. The selectivity of the antiviral effect is represented by the selectivity index (SI), calculated by dividing the CC₅₀ (cytotoxic dose for 50% of the cells) by the IC₅₀ (antiviral activity for 50 % of the cells). The tables in the above experimental part list the category to which each of the prepared compounds belong :

Compounds belonging to activity category "A" have an pIC_{50} (-log of IC_{50} when expressed in molar units) equal to or more than 7. Compounds belonging to activity category "B" have a pIC_{50} value between 6 and 7. Compounds belonging to activity category "C" have a pIC_{50} value equal to or below 6.

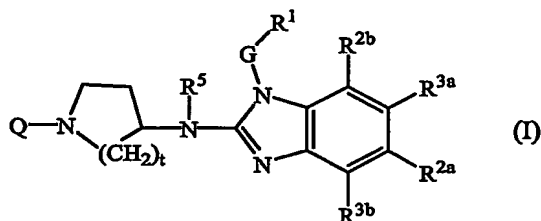
5

Automated tetrazolium-based colorimetric assays were used for determination of IC_{50} and CC_{50} of test compounds. Flat-bottom, 96-well plastic microtiter trays were filled with 180 μ l of Eagle's Basal Medium, supplemented with 5 % FCS (0% for FLU) and 20 mM Hepes buffer. Subsequently, stock solutions (7.8 x final test concentration) of compounds were added in 45 μ l volumes to a series of triplicate wells so as to allow simultaneous evaluation of their effects on virus- and mock-infected cells. Five five-fold dilutions were made directly in the microtiter trays using a robot system. Untreated virus controls, and HeLa cell controls were included in each test. Approximately 100 TCID₅₀ of Respiratory Syncytial Virus was added to two of the three rows in a volume of 50 μ l. The same volume of medium was added to the third row to measure the cytotoxicity of the compounds at the same concentrations as those used to measure the antiviral activity. After two hours of incubation, a suspension (4×10^5 cells/ml) of HeLa cells was added to all wells in a volume of 50 μ l. The cultures were incubated at 37°C in a 5% CO₂ atmosphere. Seven days after infection the cytotoxicity and the antiviral activity was examined spectrophotometrically. To each well of the microtiter tray, 25 μ l of a solution of MTT (3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide) was added. The trays were further incubated at 37°C for 2 hours, after which the medium was removed from each cup. Solubilization of the formazan crystals was achieved by adding 100 μ l 2-propanol. Complete dissolution of the formazan crystals were obtained after the trays have been placed on a plate shaker for 10 min. Finally, the absorbances were read in an eight-channel computer-controlled photometer (Multiskan MCC, Flow Laboratories) at two wavelengths (540 and 690 nm). The absorbance measured at 690 nm was automatically subtracted from the absorbance at 540 nm, so as to eliminate the effects of non-specific absorption.

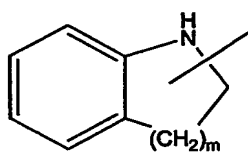
30

Claims

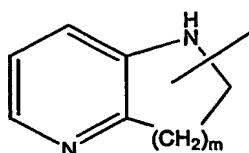
1. A compound of formula (I)



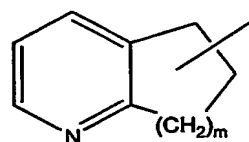
- 5 a prodrug, *N*-oxide, addition salt, quaternary amine, metal complex or stereochemically isomeric form thereof wherein
- Q is C₁₋₆alkyl optionally substituted with one or more substituents each independently selected from the group consisting of trifluoromethyl, C₃₋₇cycloalkyl, Ar², hydroxy, C₁₋₄alkoxy, C₁₋₄alkylthio, Ar²-oxy-, Ar²-thio-, Ar²(CH₂)_noxy,
- 10 Ar²(CH₂)_nthio, hydroxycarbonyl, aminocarbonyl, C₁₋₄alkylcarbonyl, Ar²carbonyl, C₁₋₄alkoxycarbonyl, Ar²(CH₂)_ncarbonyl, aminocarbonyloxy, C₁₋₄alkylcarbonyloxy, Ar²carbonyloxy, Ar²(CH₂)_ncarbonyloxy, C₁₋₄alkoxycarbonyl(CH₂)_noxy, mono- or di(C₁₋₄alkyl)aminocarbonyl, mono- or di(C₁₋₄alkyl)aminocarbonyloxy, aminosulfonyl, mono- or di(C₁₋₄alkyl)aminosulfonyl or a heterocycles selected
- 15 from the group consisting of pyrrolidinyl, pyrrolyl, dihydropyrrolyl, thiazolidinyl, imidazolyl, triazolyl, piperidinyl, homopiperidinyl, piperazinyl, morpholinyl, thiomorpholinyl, 1-oxo-thiomorpholinyl, 1,1-dioxothiomorpholinyl, pyridyl and tetrahydropyridyl, wherein each of said heterocycle may optionally be substituted with oxo or C₁₋₆alkyl;
- 20 G is a direct bond or C₁₋₁₀alkanediyl optionally substituted with one or more substituents individually selected from the group consisting of hydroxy, C₁₋₆alkyloxy, Ar¹C₁₋₆alkyloxy, C₁₋₆alkylthio, Ar¹C₁₋₆alkylthio, HO(-CH₂-CH₂-O)_n-, C₁₋₆alkyloxy(-CH₂-CH₂-O)_n- and Ar¹C₁₋₆alkyloxy(-CH₂-CH₂-O)_n-;
- 25 R¹ is Ar¹ or a monocyclic or bicyclic heterocycle being selected from piperidinyl, piperazinyl, pyridyl, pyrazinyl, pyridazinyl, pyrimidinyl, furanyl, tetrahydrofuranyl, thienyl, pyrrolyl, thiazolyl, oxazolyl, imidazolyl, isothiazolyl, pyrazolyl, isoxazolyl, oxadiazolyl, quinolinyl, quinoxaliny, benzofuranyl, benzothienyl, benzimidazolyl, benzoxazolyl, benzthiazolyl, pyridopyridyl,
- 30 naphthiridinyl, 1*H*-imidazo[4,5-*b*]pyridinyl, 3*H*-imidazo[4,5-*b*]pyridinyl, imidazo[1,2-*a*]pyridinyl, 2,3-dihydro-1,4-dioxino[2,3-*b*]pyridyl or a radical of formula



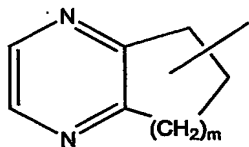
(c-1)



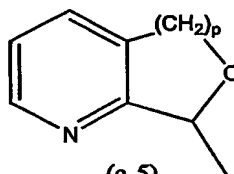
(c-2)



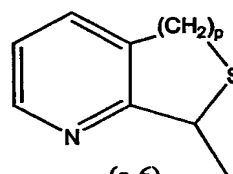
(c-3)



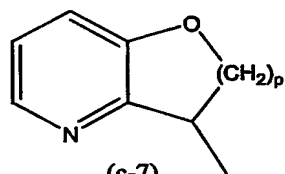
(c-4)



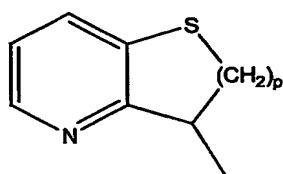
(c-5)



(c-6)



(c-7)



(c-8)

;

wherein each of said monocyclic or bicyclic heterocycles may optionally be substituted

with 1 or where possible more, such as 2, 3, 4 or 5, substituents individually

selected from the group of substituents consisting of halo, hydroxy, amino, cyano,

5

carboxyl, C₁₋₆alkyl, C₁₋₆alkyloxy, C₁₋₆alkylthio, C₁₋₆alkyloxyC₁₋₆alkyl, Ar¹,

Ar¹C₁₋₆alkyl, Ar¹C₁₋₆alkyloxy, hydroxyC₁₋₆alkyl, mono-or di(C₁₋₆alkyl)amino,

mono-or di(C₁₋₆alkyl)aminoC₁₋₆alkyl, polyhaloC₁₋₆alkyl, C₁₋₆alkylcarbonylamino,

C₁₋₆alkyl-SO₂-NR^{4a}-, Ar¹-SO₂-NR^{4a}-, C₁₋₆alkyloxycarbonyl, -C(=O)-NR^{4a}R^{4b},

HO(-CH₂-CH₂-O)_n-, halo(-CH₂-CH₂-O)_n-, C₁₋₆alkyloxy(-CH₂-CH₂-O)_n-,

10

Ar¹C₁₋₆alkyloxy(-CH₂-CH₂-O)_n- and mono-or di(C₁₋₆alkyl)amino(-CH₂-CH₂-O)_n-;

each n independently is 1, 2, 3 or 4;

one of R^{2a} and R^{3a} is C₁₋₆alkyl and the other one of R^{2a} and R^{3a} is hydrogen;

in case R^{2a} is different from hydrogen then R^{2b} is hydrogen or C₁₋₆alkyl, and R^{3b} is

hydrogen;

15

in case R^{3a} is different from hydrogen then R^{3b} is hydrogen or C₁₋₆alkyl, and R^{2b} is

hydrogen;

R^{4a} and R^{4b} can be the same or can be different relative to one another, and are each

independently hydrogen or C₁₋₆alkyl; or

R^{4a} and R^{4b} taken together may form a bivalent radical of formula -(CH₂)_s-;

20

R⁵ is hydrogen or C₁₋₆alkyl;

m is 1 or 2;

p is 1 or 2;

s is 4 or 5;

t is 1, 2 or 3;

Ar¹ is phenyl or phenyl substituted with 1 or more, such as 2, 3 or 4, substituents selected from halo, hydroxy, C₁₋₆alkyl, hydroxyC₁₋₆alkyl, polyhaloC₁₋₆alkyl, and C₁₋₆alkyloxy;

5 Ar² is phenyl or phenyl substituted with 1 or more, such as 2, 3 or 4, substituents selected from the group consisting of halo, hydroxy, amino, cyano, C₁₋₆alkyl, hydroxyC₁₋₆alkyl, polyhaloC₁₋₆alkyl, aminoC₁₋₆alkyl, C₁₋₆alkyloxy, amino-sulfonyl, aminocarbonyl, hydroxycarbonyl, C₁₋₄alkylcarbonyl, mono- or di(C₁₋₄alkyl)amino, mono- or di(C₁₋₄alkyl)aminocarbonyl, mono- or
10 di(C₁₋₄alkyl)aminosulfonyl, mono- or di(C₁₋₄alkyl)aminoC₁₋₆alkyl and C₁₋₄alkoxycarbonyl.

2. A compound as claimed in claim 1 wherein G is C₁₋₁₀alkanediyl.

15 3. A compound as claim in claim 1 or 2 wherein R¹ is pyridyl optionally substituted with 1 or 2 substituents individually selected from the group of substituents consisting of halo, hydroxy, amino, cyano, carboxyl, C₁₋₆alkyl, C₁₋₆alkyloxy, C₁₋₆alkylthio, C₁₋₆alkyloxyC₁₋₆alkyl, Ar¹, Ar¹C₁₋₆alkyl, Ar¹C₁₋₆alkyloxy, hydroxyC₁₋₆alkyl, mono-or di(C₁₋₆alkyl)amino, mono-or di(C₁₋₆alkyl)amino-
20 C₁₋₆alkyl, polyhaloC₁₋₆alkyl, C₁₋₆alkylcarbonylamino, C₁₋₆alkyl-SO₂-NR^{4a}-, Ar¹-SO₂-NR^{4a}-, C₁₋₆alkyloxycarbonyl, -C(=O)-NR^{4a}R^{4b}, HO(-CH₂-CH₂-O)_n-, halo(-CH₂-CH₂-O)_n-, C₁₋₆alkyloxy(-CH₂-CH₂-O)_n-, Ar¹C₁₋₆alkyloxy(-CH₂-CH₂-O)_n- and mono-or di(C₁₋₆alkyl)amino(-CH₂-CH₂-O)_n-.

25 4. A compound as claimed in any one of claim 1 to 3 wherein t is 2.

5. A compound as claimed in any one of claim 1 to 4 wherein the compound has the structure of the compound numbers 1 to 10 or 17 to 31 listed in tables 1 to 3.

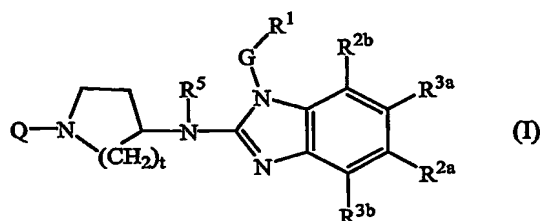
30 6. A compound as claimed in any one of claims 1 to 5 for use as a medicine.

7. A pharmaceutical composition comprising a pharmaceutically acceptable carrier, and as active ingredient a therapeutically effective amount of a compound as described in any one of claims 1 to 5.

35

ABSTRACTPIPERIDINE-AMINO-BENZIMIDAZOLE DERIVATIVES AS INHIBITORS OF
RESPIRATORY SYNCYTIAL VIRUS REPLICATION

- 5 The present invention concerns piperidine-amino-benzimidazoles having inhibitory activity on the replication of the respiratory syncytial virus and having the formula



- their prodrugs, *N*-oxides, addition salts, quaternary amines, metal complexes and stereochemically isomeric forms wherein Q is C₁₋₆alkyl optionally substituted with
- 10 trifluoromethyl, C₃₋₇cycloalkyl, Ar², hydroxy, C₁₋₄alkoxy, C₁₋₄alkylthio, Ar²-oxy-, Ar²-thio-, Ar²(CH₂)_noxy, Ar²(CH₂)_nthio, hydroxycarbonyl, aminocarbonyl, C₁₋₄alkyl-carbonyl, Ar²carbonyl, C₁₋₄alkoxycarbonyl, Ar²(CH₂)_ncarbonyl, aminocarbonyloxy, C₁₋₄alkylcarbonyloxy, Ar²carbonyloxy, Ar²(CH₂)_ncarbonyloxy, C₁₋₄alkoxy-carbonyl(CH₂)_noxy, mono- or di(C₁₋₄alkyl)aminocarbonyl, mono- or di(C₁₋₄alkyl)-
- 15 aminocarbonyloxy, aminosulfonyl, mono- or di(C₁₋₄alkyl)aminosulfonyl or a heterocycles selected from the group consisting of pyrrolidinyl, pyrrolyl, dihydropyrrolyl, thiazolidinyl, imidazolyl, triazolyl, piperidinyl, homopiperidinyl, piperazinyl, morpholinyl, thiomorpholinyl, 1-oxo-thiomorpholinyl, 1,1-dioxothiomorpholinyl, pyridyl and tetrahydropyridyl, wherein each of said
- 20 heterocycle may optionally be substituted with oxo or C₁₋₆alkyl; G is a direct bond or optionally substituted C₁₋₁₀alkanediyl; R¹ is Ar¹ or a monocyclic or bicyclic heterocycle; one of R^{2a} and R^{3a} is C₁₋₆alkyl and the other one of R^{2a} and R^{3a} is hydrogen; in case R^{2a} is different from hydrogen then R^{2b} is hydrogen or C₁₋₆alkyl, and R^{3b} is hydrogen; in case R^{3a} is different from hydrogen then R^{3b} is hydrogen or
- 25 C₁₋₆alkyl, and R^{2b} is hydrogen; t is 1, 2 or 3; Ar¹ is phenyl or substituted phenyl; and Ar² is phenyl or substituted phenyl. It further concerns their preparation and compositions comprising them, as well as their use as a medicine.

Document made available under the Patent Cooperation Treaty (PCT)

International application number: PCT/EP04/053606

International filing date: 20 December 2004 (20.12.2004)

Document type: Certified copy of priority document

Document details: Country/Office: EP
Number: 03104802.8
Filing date: 18 December 2003 (18.12.2003)

Date of receipt at the International Bureau: 08 March 2005 (08.03.2005)

Remark: Priority document submitted or transmitted to the International Bureau in compliance with Rule 17.1(a) or (b)



World Intellectual Property Organization (WIPO) - Geneva, Switzerland
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse

This Page is Inserted by IFW Indexing and Scanning Operations and is not part of the Official Record.

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images include but are not limited to the items checked:

- ☒ **BLACK BORDERS**
- ☐ **IMAGE CUT OFF AT TOP, BOTTOM OR SIDES**
- ☐ **FADED TEXT OR DRAWING**
- ☐ **BLURRED OR ILLEGIBLE TEXT OR DRAWING**
- ☐ **SKEWED/SLANTED IMAGES**
- ☐ **COLOR OR BLACK AND WHITE PHOTOGRAPHS**
- ☐ **GRAY SCALE DOCUMENTS**
- ☒ **LINES OR MARKS ON ORIGINAL DOCUMENT**
- ☒ **REFERENCE(S) OR EXHIBIT(S) SUBMITTED ARE POOR QUALITY**
- ☐ **OTHER:** _____

IMAGES ARE BEST AVAILABLE COPY.

As rescanning these documents will not correct the image problems checked, please do not report these problems to the IFW Image Problem Mailbox.